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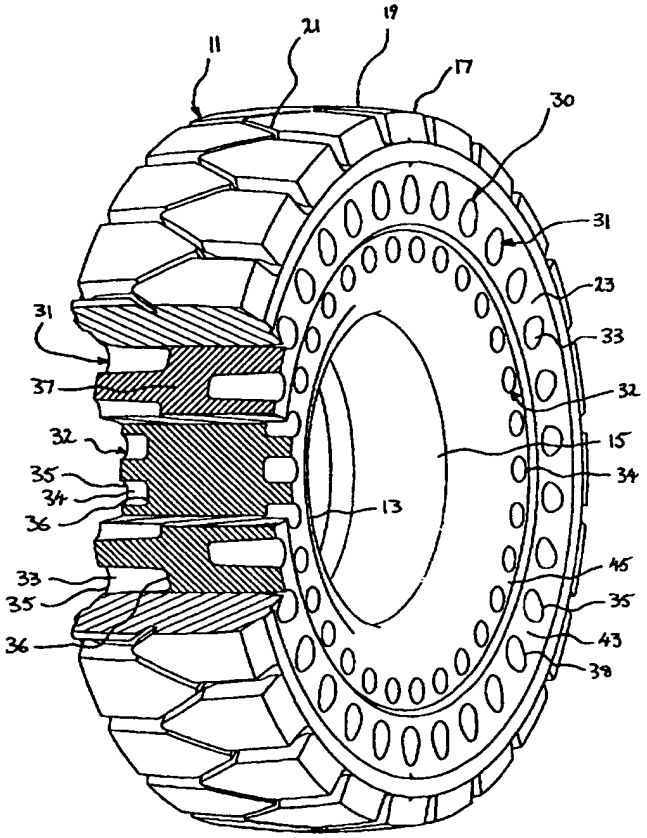
(54) Title: CYCLICALLY MOVEABLE GROUND-ENGAGING STRUCTURE

(57) Abstract

A cyclically moveable ground-engaging structure such as a tyre. The tyre comprises a resiliently deformable body (11) having a inner surface (15) and two opposed lateral sides (23). A plurality of cavities (11) provided in the body, the cavities being in a first set (31) and a second set (32) on each of the two lateral sides of the body. Each cavity has one end thereof opening onto the respective side (23) of the body and is closed at the other end. The first set (31) of cavities on each side is disposed outwardly of the second set (32) of cavities on the same side in the direction away from the inner surface (15). The cavities (33) in the first set (31) on each side are offset in the direction of cyclical movement with respect to the cavities (34) in the second set (32) on the same side. The cavities (33) in the first set (31) on one side of the body are offset in the direction of cyclical movement with respect to the cavities (33) in the first set (31) on the other side of the body, and the cavities (34) in the second set (32) on one side of the body are offset in the direction of cyclical movement with respect to the cavities (34) in the second set (32) on the other side of the body. With this arrangement, the cavities (33, 34) on each side (23) of the body (11) are staggered in the direction of cyclical movement and so no one of the cavities (33, 34) is in alignment with any other one of the cavities in a direction normal to the direction of cyclical movement.



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TITLE

"Cyclically Moveable Ground-Engaging Structure"

TECHNICAL FIELD

The present invention relates to cyclically moveable ground-engaging structure for providing cushioning on an engaged ground surface. The ground-engaging structure may, for example, comprise a tyre for a wheel or a ground-contacting structure for an endless track. More particularly, the invention relates to such ground-engaging structures which are of non-pneumatic character.

BACKGROUND OF THE INVENTION

The present invention is a development of a tyre disclosed in International Application PCT/AU95/00514, the contents of which are incorporated herein by way of reference.

The above mentioned international application discloses a cyclically moveable ground-engaging structure in the form of a tyre comprising a resiliently deformable body having an inner surface for engagement with a cyclically moveable support such as wheel rim. The annular body is provided with a plurality of cavities which enhance its ability to deform. The cavities comprise a first set of cavities arranged in circumferentially spaced apart relationship and a second set of cavities arranged in circumferentially spaced apart relationship. The cavities extend crosswise through the body and open onto opposed sides of the tyre. The first set of cavities is positioned outwardly of the second set in the direction away from the inner surface, and each of the cavities in the first set is aligned (in a direction normal to the direction of cyclical movement) with a respective one of the cavities in the second set.

With this arrangement, solid zones providing load bearing webs are defined between adjacent cavities. A deficiency of such an arrangement is that the tyre has a series of alternating comparatively hard and soft sectors which extend

across the tyre between the opposed sides thereof, the hard sectors corresponding to the solid zones and the soft sectors corresponding to the zones where the cavities are present. The alternating hard and soft sectors are not conducive to a smooth ride.

The present invention seeks to provide a ground-engaging structure which offers improved ride characteristics.

SUMMARY OF THE INVENTION

The present invention provides a cyclically moveable ground-engaging structure comprising a resiliently deformable body having an inner surface and two opposed lateral sides, a plurality of cavities on each of two opposed sides of the body, each cavity having one end thereof opening onto the respective side of the body and being closed or of a reduced cross-sectional area at the other end, the cavities on one side of the body being offset in the direction of cyclical movement with respect to the cavities on the other side of the body.

With such an arrangement, the cavities are staggered in the direction of cyclical movement and this provides an arrangement of hard and soft sectors which is more conducive to a consistent ride than the tyre disclosed in the aforementioned international application.

The cavities comprise a first set of cavities on each of the two opposed sides of the body, and there may be provided a second set of cavities on each of the two opposed sides of the body, the cavities in the second sets each having one end thereof opening onto the respective side of the body and being closed or of a reduced cross-sectional area at the other end, the first set of cavities on each side being disposed outwardly of the second set of cavities on the same side in the direction away from the inner surface, the cavities in the first set on each side being offset in the direction of cyclical movement with respect to the cavities in the second set on the same side, the cavities in the first set on one side of the body being offset in the direction of cyclical movement with respect to the cavities in the first set on the other side of the body, and the cavities in the

second set on one side of the body being offset in the direction of cyclical movement with respect to the cavities in the second set on the other side of the body.

With this arrangement, the cavities on each side of the body are staggered in the direction of cyclical movement and so no one of said cavities is in alignment with any other one of said cavities in a direction normal to the direction of cyclical movement. In this way, the cavities are distributed within the body in a manner which avoids, or at least reduces the effect of, discrete hard and soft zones and so offers an even more consistent ride.

Preferably, the cavities on each side of the body open at their outer ends onto the respective side and are closed at their inner ends.

Preferably, the inner end of each cavity terminates before the centre of the tyre. With this arrangement, the ground-engaging structure is provided with a central web extending circumferentially within the body. This central web provides the ground-engaging structure with a central region which is harder than the outer regions adjacent the lateral sides. This is a desirable feature in tyres. The presence of the central web allows the ground-engaging structure to withstand the high twisting forces to which it is likely to be exposed during steering.

Preferably, the cavities in each set are in spaced apart relationship in the direction of cyclical movement of the structure, the spacing between adjacent cavities in each set being about the same as the maximum dimension of the cavity in the direction of cyclical movement. However, it should be appreciated that the relative size of the cavities and the spacings therebetween can be varied, such as for example to accommodate different rubber compounds used to manufacture the ground-engaging structure. Where the cross-sectional size of the cavities is less than the spacings therebetween, load-bearing radial webs may be formed on each side of the body between the cavities.

Preferably, the cavities are of a rounded shape in cross-section.

The rounded shape of the cavities in the first set may comprise a pair of spaced apart arcs with the concave sides thereof in facing relationship, and intermediate lines extending between the arcs. Where the two arcs have unequal radii of curvature, the larger arc may be disposed towards the inner end of the tyre. The intermediate lines extending between the arcs may be curved, with the result that the shape of the cavity in cross-section may be a closed curve such as an ovate.

Each cavity is preferably longitudinal and of a substantially constant orientation throughout its length within the body.

The cavities may extend axially into the body so as to be normal to the direction of cyclical movement. Alternatively, the cavities, or at least some of the cavities, may be inclined in the axial direction and thereby inclined to the direction of cyclical movement.

While the cavities in the second set are conventionally of a generally circular cross-section, they may be of any other suitable cross-sectional shape, such as for example the shape of the cavities in the first set.

The ground-engaging structure may be of a one-piece construction or it may be formed of a plurality of ground-engaging segments which can be assembled together to provide a ground-engaging structure of composite construction. A ground-engaging structure of one-piece construction is advantageous in that it generates less heat during operation than a structure of composite construction. This is because the one-piece construction does not have the interfaces between the segments, which exist in the composite construction and which are in rubbing contact during cyclical movement of the ground-engaging structure.

The invention also provides a ground-engaging segment which along with other such segments can be assembled to form a ground-engaging structure as hereinbefore defined.

The present invention further provides a cyclically moveable ground-engaging structure comprising a resiliently deformable body having an inner surface and two opposed lateral sides, a plurality of cavities provided in the body, said cavities comprising a first set of cavities and a second set of cavities on each of the two lateral sides of the body, each cavity having one end thereof opening onto the respective side of the body and being closed or of a reduced cross-sectional area at the other end, the first set of cavities on each side being disposed outwardly of the second set of cavities on the same side in the direction away from the inner surface, the cavities in the first set on each side being offset in the direction of cyclical movement with respect to the cavities in the second set on the same side, the cavities in the first set on one side of the body being offset in the direction of cyclical movement with respect to the cavities in the first set on the other side of the body, and the cavities in the second set on one side of the body being offset in the direction of cyclical movement with respect to the cavities in the second set on the other side of the body.

The present invention further provides a tyre comprising a resiliently deformable annular body having an inner surface and two opposed lateral sides, a plurality of cavities provided in the body, said cavities comprising a first set of cavities and a second set of cavities on each of the two lateral sides of the body, each cavity having one end thereof opening onto the respective side of the body and being closed or of a reduced cross-sectional area at the other end, the first set of cavities on each side being disposed radially outwardly of the second set of cavities on the same side in the direction away from the inner surface, the cavities in the first set on each side being circumferentially offset with respect to the cavities in the second set on the same side, the cavities in the first set on one side of the body being circumferentially offset with respect to the cavities in the first set on the other side of the body, and the cavities in the second set on one side of the body being circumferentially offset with respect to the cavities in the second set on the other side of the body.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood by reference to the following description of several specific embodiment thereof as shown in the accompanying drawings in which:

Figure 1 is a perspective view of a tyre according to the first embodiment, with a portion thereof cut away to reveal details of cavities provided therein;

Figure 2 is a partial sectional elevation of the tyre according to the first embodiment;

Figure 3 is a view similar to Figure 1 except that hidden detail is shown to illustrate the appearance of the tyre on the reverse (hidden) side thereof;

Figure 4 is an end view of the tyre;

Figure 5 is a cross-section on line 4-4 of Figure 2;

Figure 6 is a graphical presentation illustrating deflection of the tyre under constant load during rolling movement thereof;

Figure 7 is a view similar to Figure 6 but in respect of a tyre disclosed in the aforementioned international application;

Figures 8 and 9 are also views similar to Figure 6 but in respect of other tyres having different cavity arrangements for the purpose of illustration.

Figure 10 is a perspective view of a tyre according to a second embodiment, with a portion thereof cut away to reveal details of cavities provided therein;

Figure 11 is a partial sectional elevation of a tyre according to a second embodiment; and

Figure 12 is a view similar to Figure 11 except that hidden detail is shown to illustrate the appearance of the tyre on the reverse (hidden) side thereof.

DESCRIPTION OF PREFERRED EMBODIMENTS

The embodiments shown in the drawings are each directed to a cyclically moveable ground-engaging structure in the form of a non-pneumatic tyre which is intended primarily for operation in commercial and industrial environments such as on forklifts.

Referring now to Figures 1 to 5, the tyre according to the first embodiment comprises an annular body 11 formed of elastomeric material such as rubber. The annular body 11 may incorporate suitable reinforcement 12.

The annular body 11 comprises a radially inner end 13 having an inner face 15 for engagement with a cyclically moveable support such as a wheel rim (not shown) and a radially outer end 17 including an outer face 19 for contact with the ground. A tread formation 21 is provided on the outer face 19 for engagement with the ground surface. A pair of opposed lateral side walls 23 extend between the inner portion 13 and the outer portion 17.

In this embodiment, the inner end 13 is configured for engagement with a wheel rim of the conventional split-rim type.

A plurality of longitudinal cavities 30 are provided within the annular body to enhance its resilience for the purposes of providing a cushioned ride. The cavities are arranged in two sets, being a first set 31 and a second set 32 on each side of the tyre. The first set 31 comprises a series of circumferentially spaced cavities 33, and the second set 32 comprises a series of circumferentially spaced cavities 34. The cavities 34 in the second set 32 are positioned radially inwardly of the cavities 33 in the first set 31, as shown in the drawings.

Each cavity 33, 34 opens onto its respective side wall 23 of the tyre at its outer end 35 and extends crosswise into the body in an axial direction with respect to the tyre. The cavities 33, 34 are closed at their inner ends 36 and are of a length which is less than half the width of the tyre such that the inner end of the cavity terminates before the centre of the tyre. With this arrangement, the central region of the tyre is provided with a load-bearing central web 37 which extends circumferentially around the annular body 11.

The cavities 33, 34 in the first and second sets are of rounded configuration in cross-section.

More particularly, each cavity 33 in the first set 31 has a cross-sectional shape which is an elongate closed curve 38 of ovate form. The closed curve 38 defining the cross-sectional shape of each cavity 33 can be considered as two arcs 39a, 39b respectively defining a radially outer end portion and a radially inner end portion of the cross-sectional shape of the cavity. The two arcs 39a, 39b are connected by intermediate lines 39c, 39d to complete the closed curves. The intermediate lines 39c, 39d are arcuate.

The elongate closed curve 38 of each cavity 33 has a major axis centred along the length thereof. The closed curve 38 also has a further axis which is transverse to the major axis and which corresponds to the maximum transverse dimension of the curve.

The cavities 33 are each oriented such that the larger end thereof is disposed towards the radially inner end of the tyre. This arrangement is advantageous as it has the effect of avoiding the formation of sharp corners in the cross-sectional shape of the cavity as it deflects under normal loading conditions on the tyre. Indeed, the ovate shape of the cavities tends to deflect towards a generally circular shape as the tyre is progressively loaded in normal operating conditions.

The ovate shape of each cavity 33 in cross-section and the orientation of the cavity provides an arrangement in which the centroid of the cavity is adjacent the end thereof which is disposed towards the radially inner end of the tyre. With

this orientation, the major axis of the ovate shape extends in a radial direction of the tyre.

The cavities 34 in the second set 32 are of generally circular shape in cross-section.

The cavities 33, 34 in each set are disposed in circumferentially spaced apart relationship, on each side of the tyre, as best seen in Figures 1 and 2. Specifically, the cavities 33 in the first set 31 are spaced apart a distance corresponding to the maximum dimension of the cross-sectional shape in the circumferential direction of the tyre. In other words, the spacing 43 between adjacent cavities 33 in each first set 31 corresponds to the maximum transverse dimension of the closed curve 38 which defines the cross-sectional shape of the cavity. Similarly, the spacing 45 between the cavities 34 in each second set 32 is approximately equal to the diameter of the circular cross-sectional shape.

The cavities 33, 34 in the first and second sets on each side of the tyre are circumferentially offset (staggered) with respect to each other, as best seen in Figures 1 and 2. In this regard, it can be seen that the spacings 43 between neighbouring cavities 33 in the first set 31 are in radial alignment with the cavity 34 in the second set 32 on each side of the tyre. Similarly, the spacings 45 between neighbouring cavities 34 in the second set 32 are in radial alignment with the cavities 33 in the first set 31.

Further, the cavities 33 in the first set 31 on one side of the tyre are circumferentially offset (staggered) with respect to the corresponding cavities 33 on the other side of the tyre, as shown in Figure 2. Similarly, the cavities 34 in the second set 32 of cavities on each side of the tyre are circumferentially offset (staggered) with respect to the corresponding cavities 34 on the other side of the tyre.

With staggering of the cavities 33, 34 on each side of tyre and also staggering of corresponding cavities on the opposed sides of the tyre, no one cavity 33, 34 on either side of the tyre is in radial alignment with any other one of the cavities on

the same side of the tyre. Furthermore, apart from the central web 37, there are no load-bearing webs extending radially through the annular body 11 between the radially inner and outer ends thereof. This feature is particularly advantageous because it ensures that there is not an excessive range of deflections within the tyre when it is rolling under load over a surface, and so is conducive to a regular ride. This can be better understood by reference to Figures 5 to 8 of the drawings. Figure 5 illustrates the magnitude of the variation in the deflection of the tyre according to the embodiment when under load and rolling over a smooth surface. The drawing shows that the deflections are at a comparatively high frequency and are of a comparatively low magnitude. Indeed, the magnitude of variation in the deflection is about 2.5% of the total deflection of the tyre when under load.

The ride provided by the tyre according to the embodiment can be compared with that offered by the tyre disclosed in aforementioned International Application PCT/AU95/00514 by reference to Figure 6 of the drawings. In such a tyre (which is illustrated schematically) cavities A in the first set are radially aligned with cavities B in the second set, and radially extending load-bearing webs C are defined between the cavities. The cavities A and B extend entirely through the tyre and open onto opposed sides thereof. The solid sectors of the tyre corresponding to the load-bearing webs C offer comparatively little deflection, and the sectors in which the cavities A and B are present offer significantly more deflection, as seen in Figure 6. Indeed, the magnitude of the variation in deflection is approximately 10% of the total deflection under load. Accordingly, the tyre provides a very irregular ride.

The ride is somewhat improved by providing a tyre in which the cores A and B are circumferentially offset while still extending entirely through the body. This arrangement is illustrated on Figure 7 from which it can be seen that the magnitude of the variations in the deflections are a little more regular but certainly not as regular as the tyre according to the embodiment. The magnitude of the variation in deflection in Figure 7 is about 7.5% of the total deflection

under load. The graph shows two sets of peaks, the larger one corresponding to cavities A and the smaller one corresponding to cavities B.

The ride is improved somewhat further by forming the cavities A and B as core holes closed at their inner ends and aligned on opposed sides of the tyre. This arrangement provides a central load-bearing web. The magnitude of the variation in the deflection in Figure 8 is about 5% of the total deflection under load.

Comparing the deflection of the tyre of the present embodiment as shown in Figure 5 with that of the tyre of Figure 8, the benefit of staggering the cavities on opposed sides of the tyre so that they are circumferentially offset is apparent.

The tyre of the present embodiment is of overall stiffer construction than the tyres illustrated in Figures 6, 7 and 8. This increased stiffness arises because of the arrangement of the cavities within the tyre. The increased stiffness can be offset by use of a softer rubber to construct the tyres. This has the benefit of less hysteresis, and so generates less heat and offers a longer life.

From the foregoing, it is evident that the first embodiment provides a tyre having a comparatively smooth ride, so providing some of the benefits of a pneumatic tyre without susceptibility to puncturing. The tyre may well also use less rubber than the tyre disclosed in the aforementioned international application. Alternatively, if a hard rubber is used the cavities may be made larger to compensate for the increased stiffness due to the arrangement of the cavities. Further, the present tyre also has improved durability owing to the presence of the central web which allows it to withstand the high twisting forces to which it is likely to be exposed during steering.

Referring now to Figures 10, 11 and 12, there is shown a tyre 11 according to a second embodiment. The tyre is similar to the first embodiment with the exception that there is only one set 31 of cavities in each side of the tyre, said one set corresponding to the first set 31 of cavities in the tyre of the first embodiment. In this second embodiment, the set 31 of cavities comprises a

series of circumferentially spaced cavities 33 on each side of the tyre. The cavities 33 on one side of the tyre are each identified by reference numeral 33a and the cavities 33 on the other side of the tyre are each identified by reference numeral 33b. The cavities 33a on one side of the tyre are circumferentially offset (staggered) with respect to the cavities 33b on the other side, as best shown in Figure 10.

In the first and second embodiments, the cavities 33 are of an ovate shape. The cavities 33 (and indeed the cavities 34 in the first embodiment) may of course be of any other suitable shape. For instance, the intermediate lines 39c, 39d connecting the arcs 39a, 39b of each cavity 33 may be straight or of any suitable shape, as an alternative to the arcuate shape described in relation to the first embodiment.

Further, the two arcs 39a, 39b may be of equal radii of curvature as an alternative to the arrangement shown in the drawings where the radii of curvature are unequal. Still further, the radius of curvature of one of the arcs of each cavity 33 may be only slightly larger than the radius of curvature of the other arc, instead of being considerably larger as is the case in the illustrated embodiments.

It should be appreciated that the scope of the invention is not limited to the scope of the embodiments described.

CLAIMS

1. A cyclically moveable ground-engaging structure comprising a resiliently deformable body having an inner surface and two opposed lateral sides, a plurality of cavities on each of two opposed sides of the body, each cavity having one end thereof opening onto the respective side of the body and being closed or of a reduced cross-sectional area at the other end, the cavities on one side of the body being offset in the direction of cyclical movement with respect to the cavities on the other side of the body.

2. A cyclically moveable ground-engaging structure according to claim 1 wherein the cavities comprise a first set of cavities on each of the two opposed sides of the body, and wherein there is provided a second set of cavities on each of the two opposed sides of the body, the cavities in the second sets each having one end thereof opening onto the respective side of the body and being closed or of a reduced cross-sectional area at the other end, the first set of cavities on each side being disposed outwardly of the second set of cavities on the same side in the direction away from the inner surface, the cavities in the first set on each side being offset in the direction of cyclical movement with respect to the cavities in the second set on the same side, the cavities in the first set on one side of the body being offset in the direction of cyclical movement with respect to the cavities in the first set on the other side of the body, and the cavities in the second set on one side of the body being offset in the direction of cyclical movement with respect to the cavities in the second set on the other side of the body.

3. A cyclically moveable ground-engaging structure according to claim 1 or 2 wherein the cavities on each side of the body open at their outer ends onto the respective side and are closed at their inner ends.

4. A cyclically moveable ground-engaging structure according to claim 3 wherein the inner end of each cavity terminates before the centre of the body.

5. A cyclically moveable ground-engaging structure according to any one of the preceding claims wherein the cavities in each set are in spaced apart relationship in the direction of cyclical movement of the structure, the spacing between adjacent cavities in each set being about the same as the maximum dimension of the cavity in the direction of cyclical movement.

6. A cyclically moveable ground-engaging structure according to any one of the preceding claims wherein the cavities are of a rounded shape in cross-section.

7. A cyclically moveable ground-engaging structure according to claim 6 wherein the cavities in the first set are ovate in cross-section.

8. A cyclically moveable ground-engaging structure according to claim 7 wherein each cavity is oriented so that the larger end of the ovate shape is disposed towards the inner surface of the body.

9. A cyclically moveable ground-engaging structure according to claim 6, 7 or 8 wherein the cross-section of each of the cavities in the first set comprises a pair of spaced apart arcs with the concave sides thereof in facing relationship and intermediate lines extending between the arcs.

10. A cyclically moveable ground-engaging structure according to claim 9 wherein said arcs have radii of curvature which are unequal.

11. A cyclically moveable ground-engaging structure according to claim 9 or 10 wherein said lines extending between the arcs are curved.

12. A cyclically moveable ground-engaging structure according to claim 9 or 10 wherein said lines extending between the arcs are substantially straight.

13. A cyclically moveable ground-engaging structure according to claim 6 wherein the cavities in the second set are of substantially circular cross-section.

14. A cyclically moveable ground-engaging structure according to any one of the preceding claims wherein each cavity is longitudinal and of substantially constant orientation throughout its length within the body.

15. A cyclically moveable ground-engaging structure according to any one of the preceding claims wherein the cavities extend axially into the body so as to be normal to the direction of cyclical movement.

16. A cyclically moveable ground-engaging structure according to any one of claims 1 to 14 wherein the cavities are inclined to the direction of cyclical movement.

17. A cyclically moveable ground-engaging structure according to any one of the preceding claims wherein the body is annular.

18. A cyclically moveable ground-engaging structure according to any one of the preceding claims characterised in that it is of one-piece construction.

19. A cyclically moveable ground-engaging structure according to any one of claims 1 to 17 characterised in that it is formed of a plurality of ground-engaging segments which can be assembled together to provide a ground-engaging structure of composite construction.

20. A ground-engaging segment which along with other such segments can be assembled to form a ground-engaging structure as claimed in claim 19.

21. A tyre comprising a resiliently deformable annular body having an inner surface and two opposed lateral sides, a plurality of cavities provided in the body, said cavities comprising a first set of cavities and a second set of cavities on each of the two lateral sides of the body, each cavity having one end thereof opening onto the respective side of the body and being closed or of a reduced cross-sectional area at the other end, the first set of cavities on each side being disposed radially outwardly of the second set of cavities on the same side in the direction away from the inner surface, the cavities in the first set on each side being circumferentially offset with respect to the cavities in the second set on the same side, the cavities in the first set on one side of the body being circumferentially offset with respect to the cavities in the first set on the other side of the body, and the cavities in the second set on one side of the body being circumferentially offset with respect to the cavities in the second set on the other side of the body.

22. A cyclically movable ground engaging structure substantially as herein described with respect to the accompanying drawings.

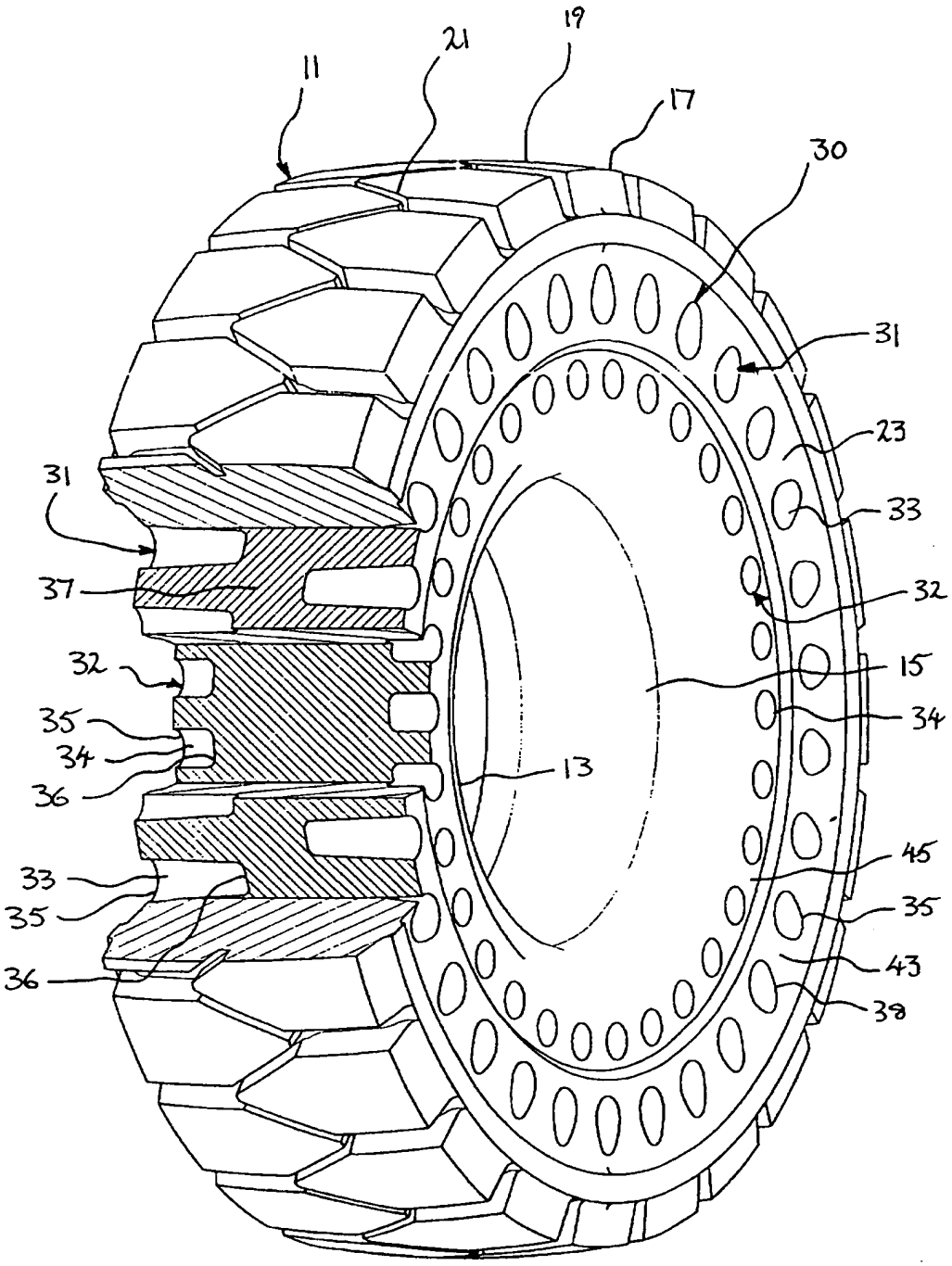
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Fig. 1.

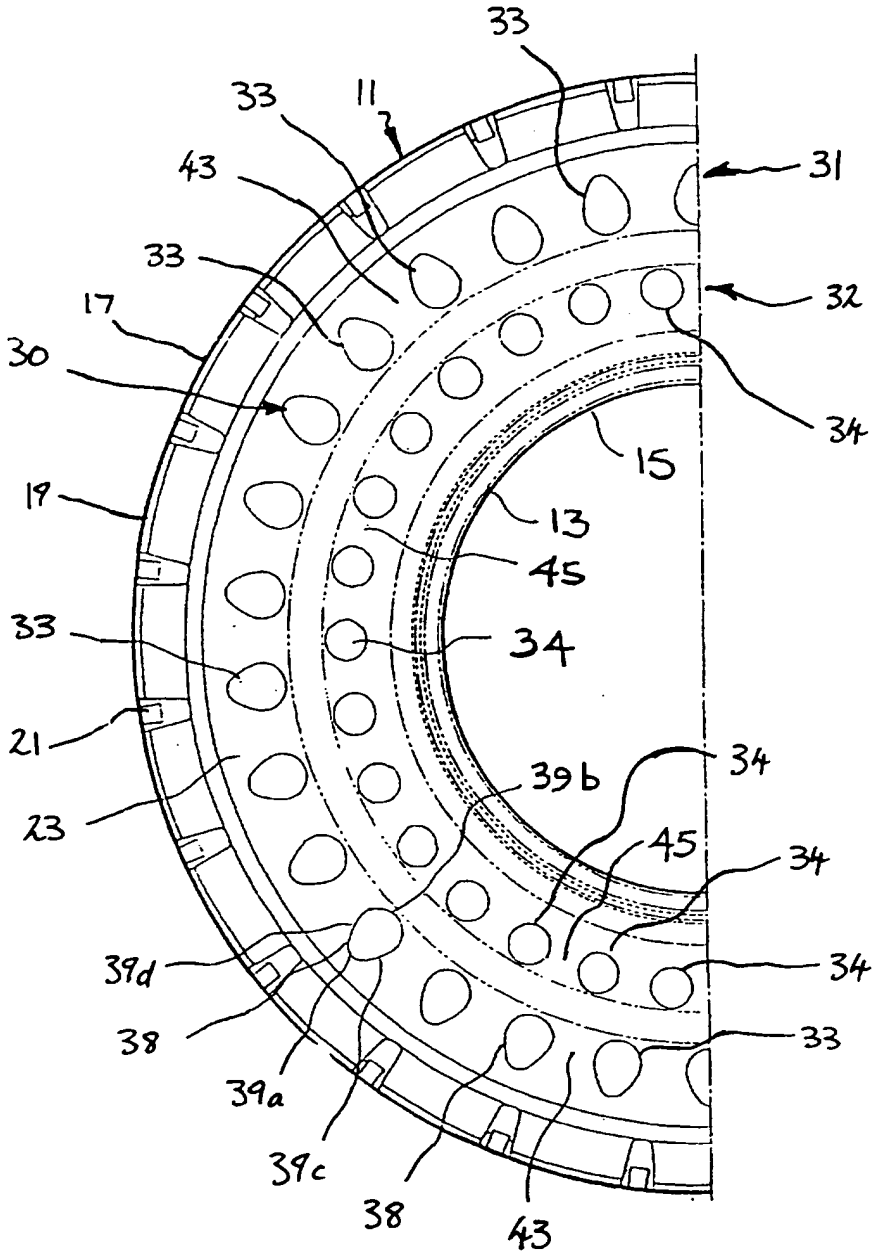
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Fig 2

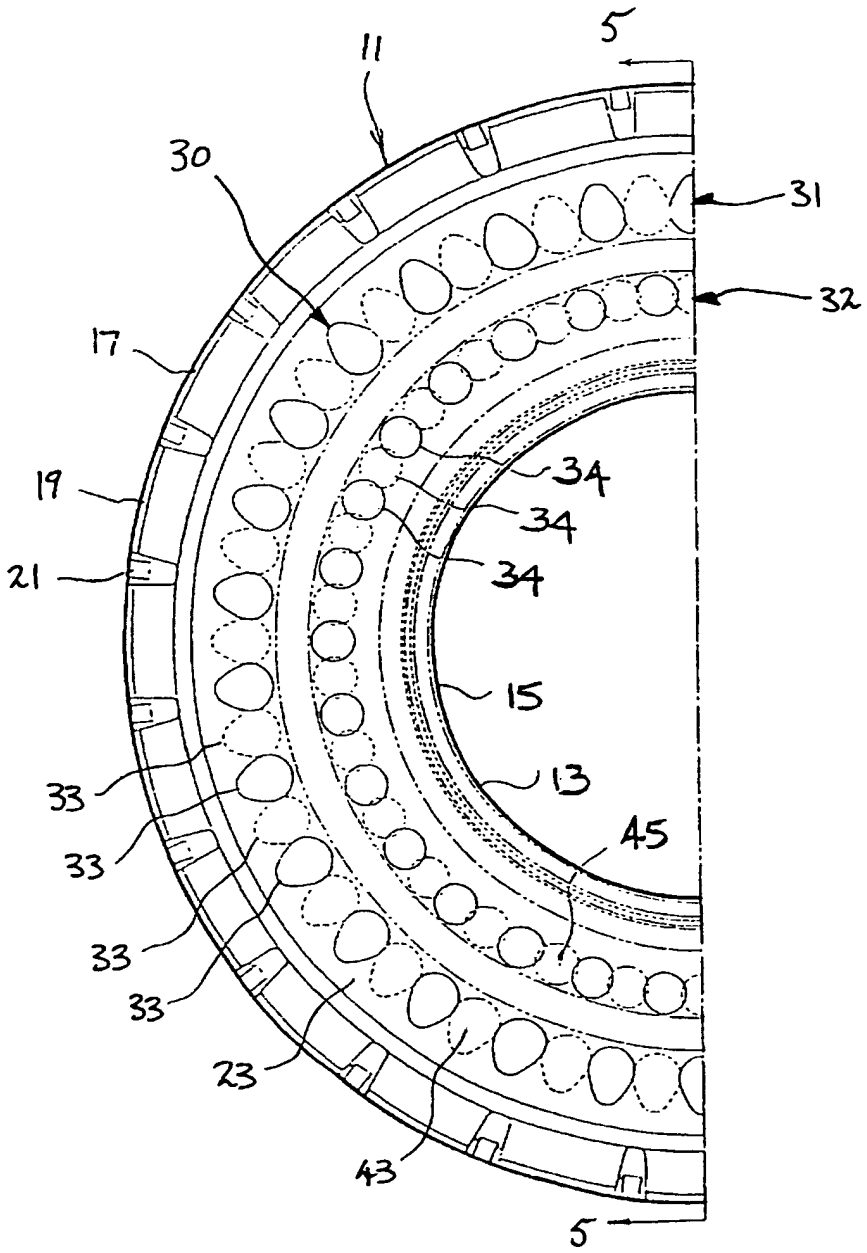

Fig 3

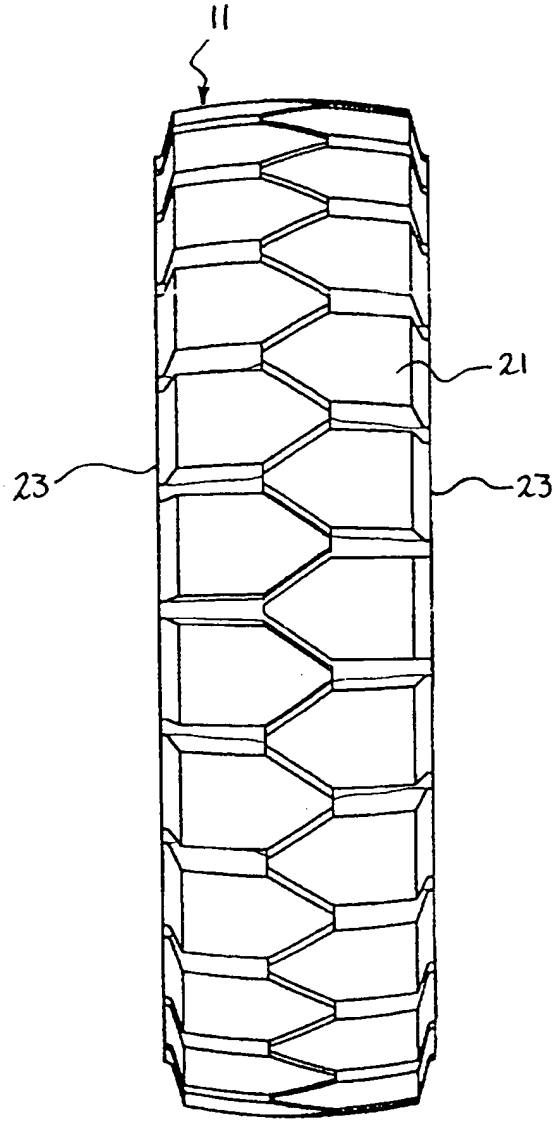

Fig. 4

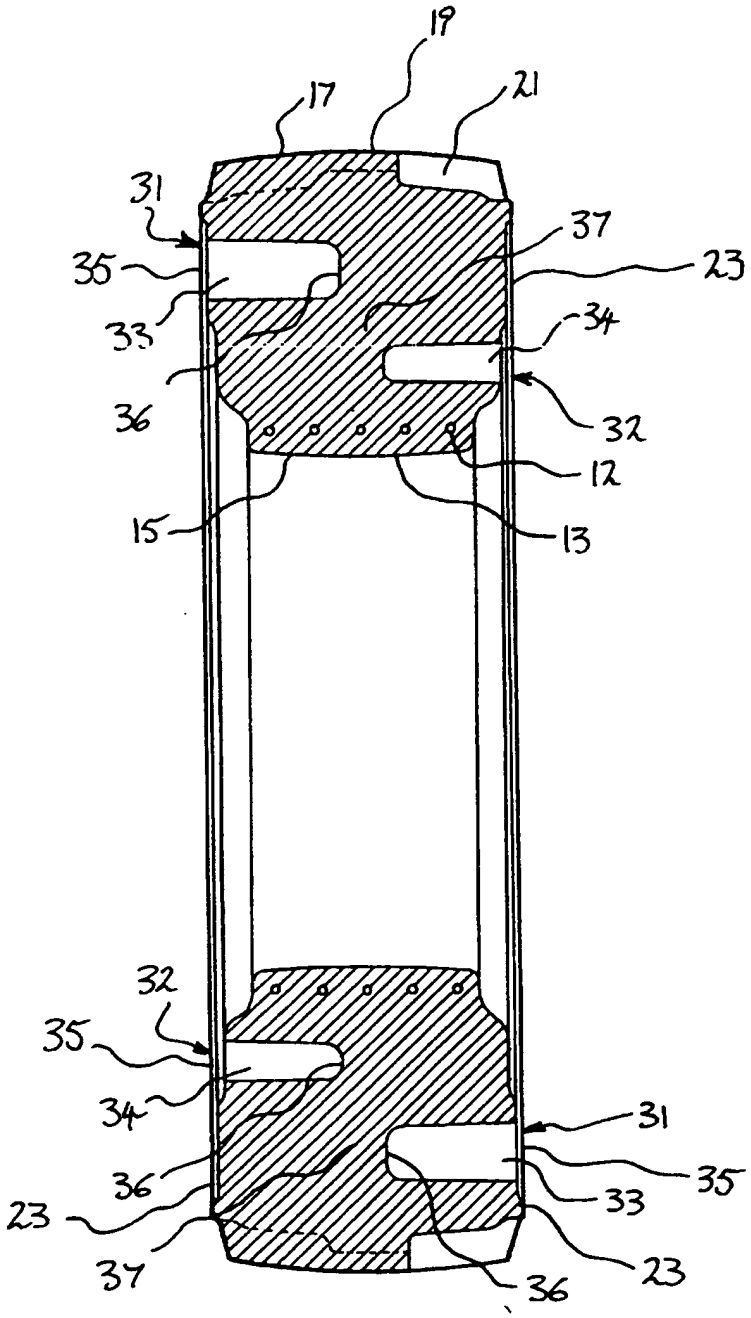
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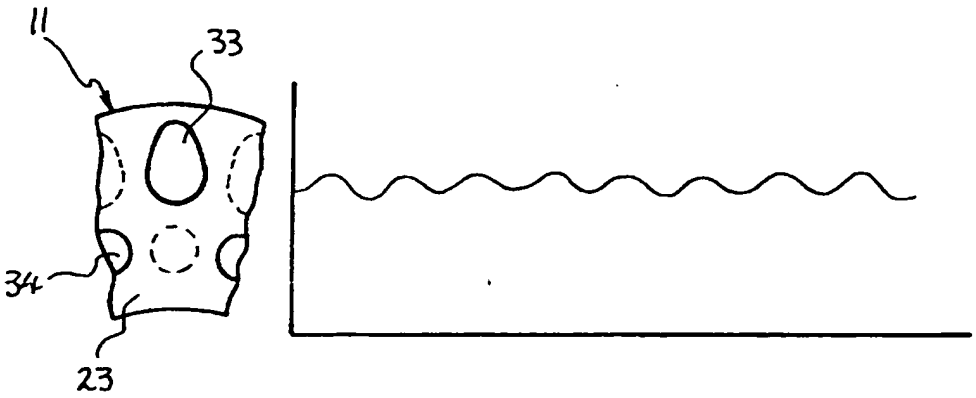
Fig. 5.



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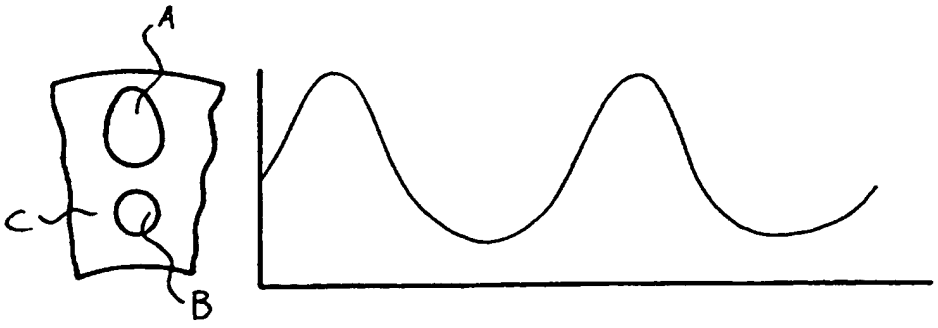

Fig. 7

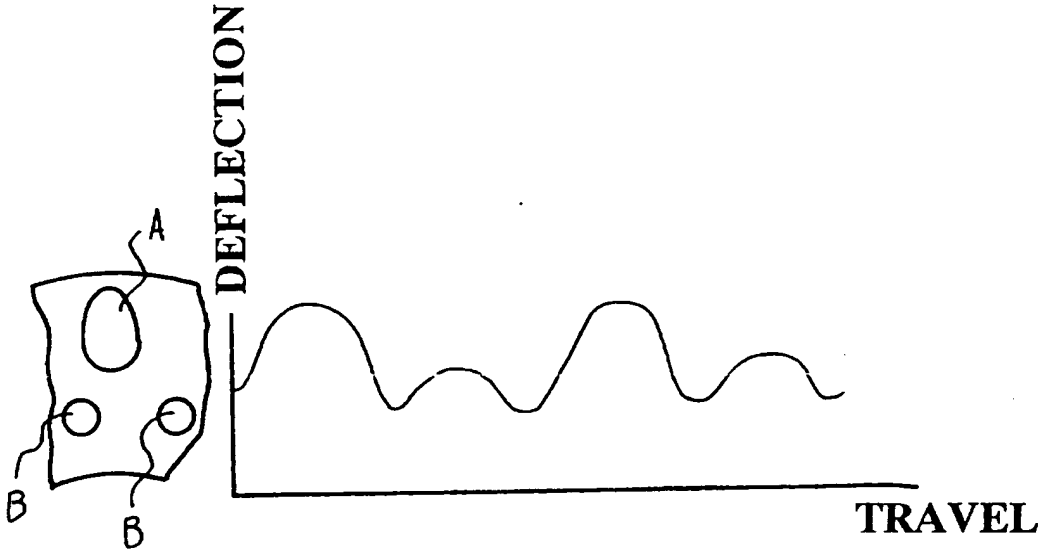

Fig. 8

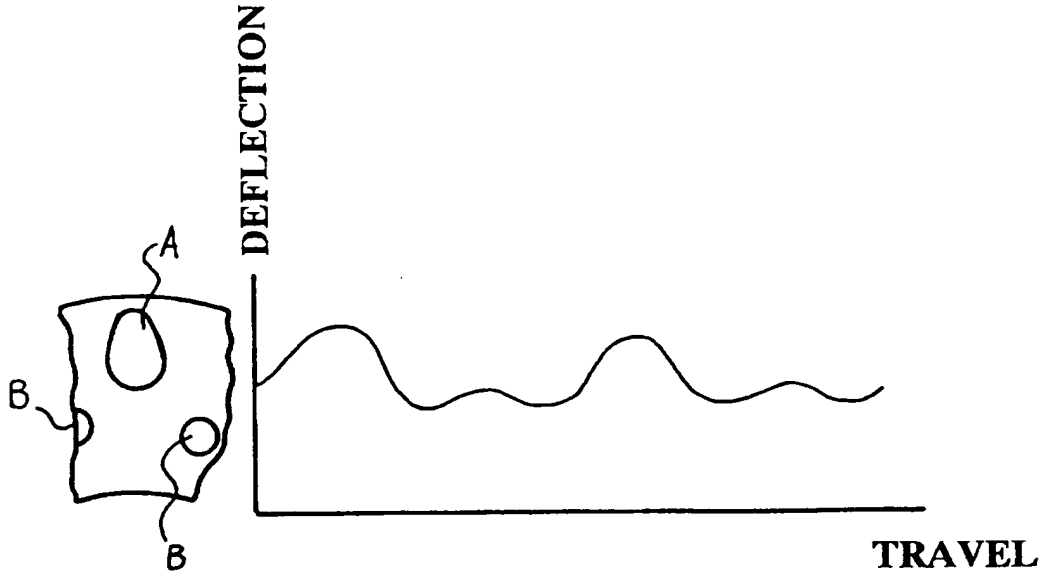

Fig. 9

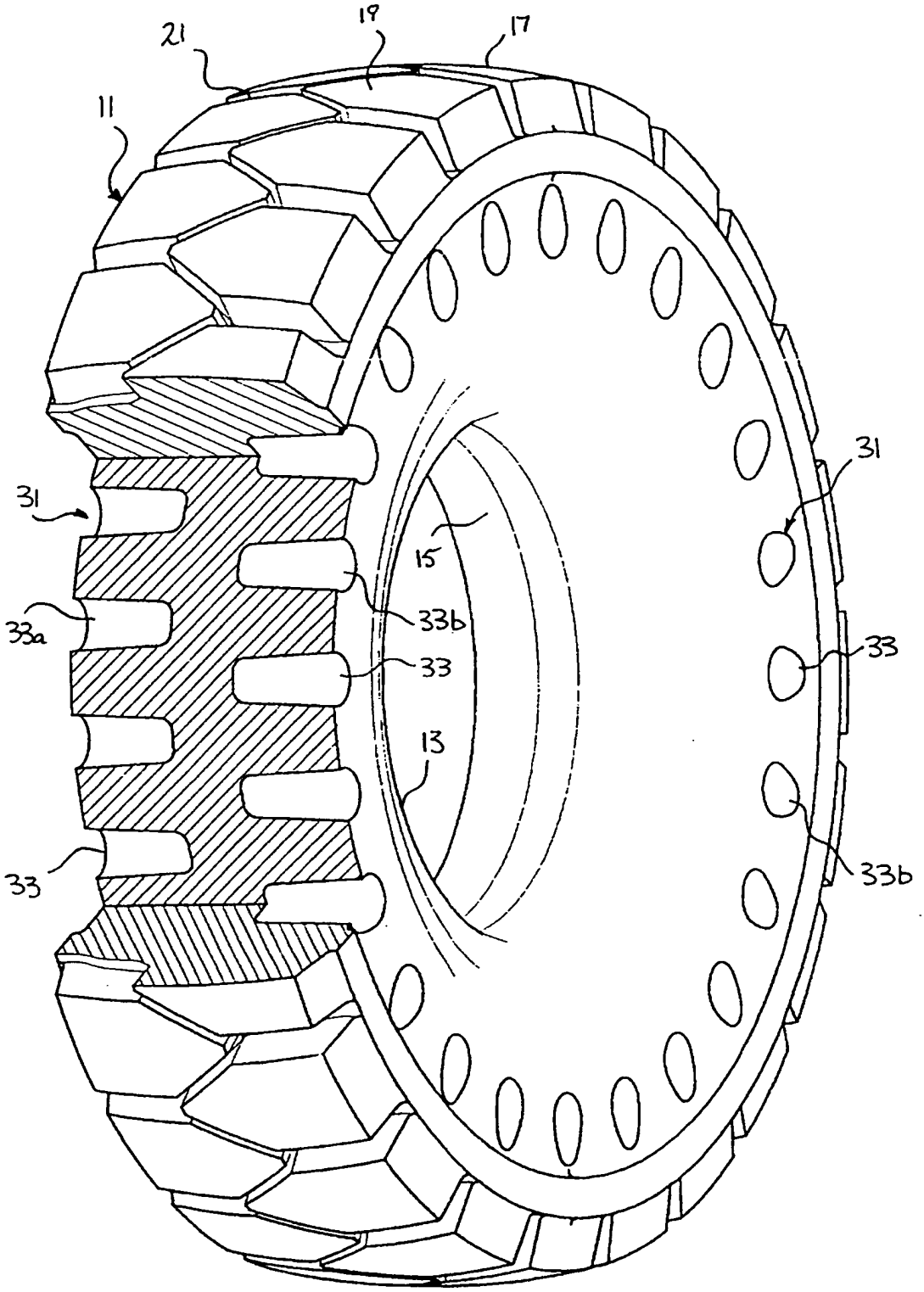

Fig 10

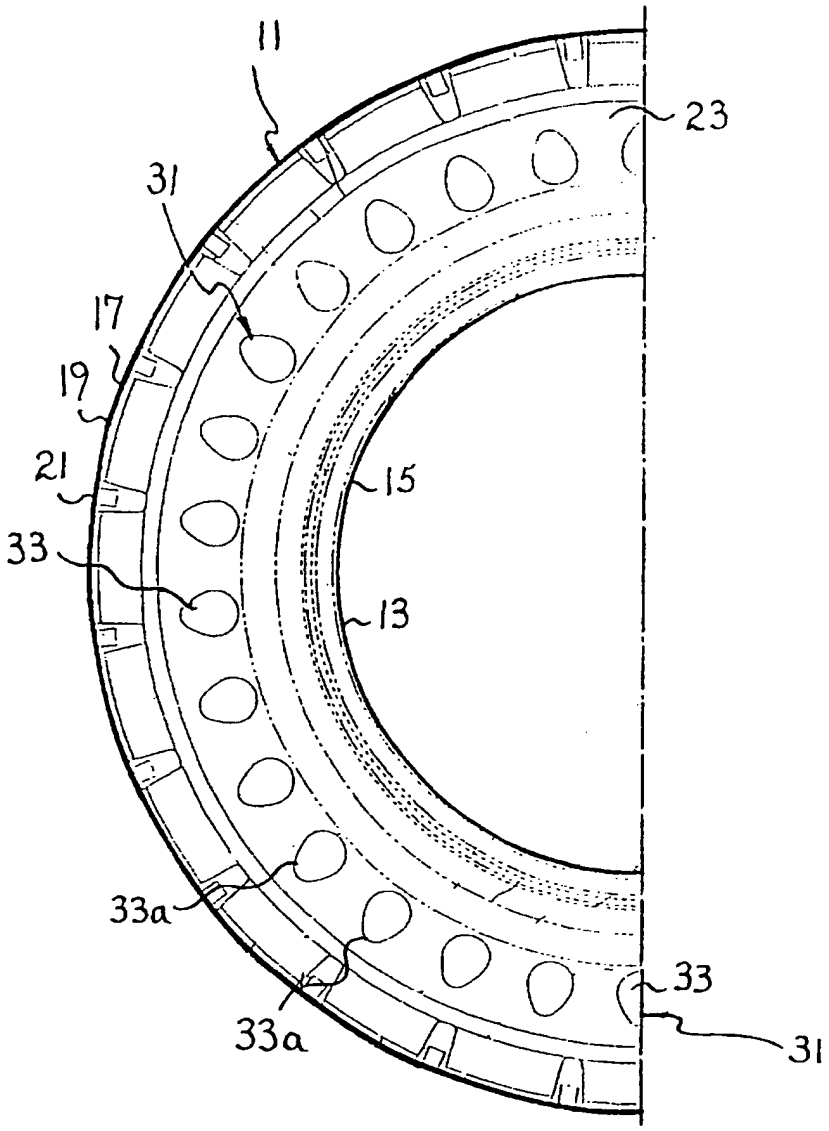

Fig 11.

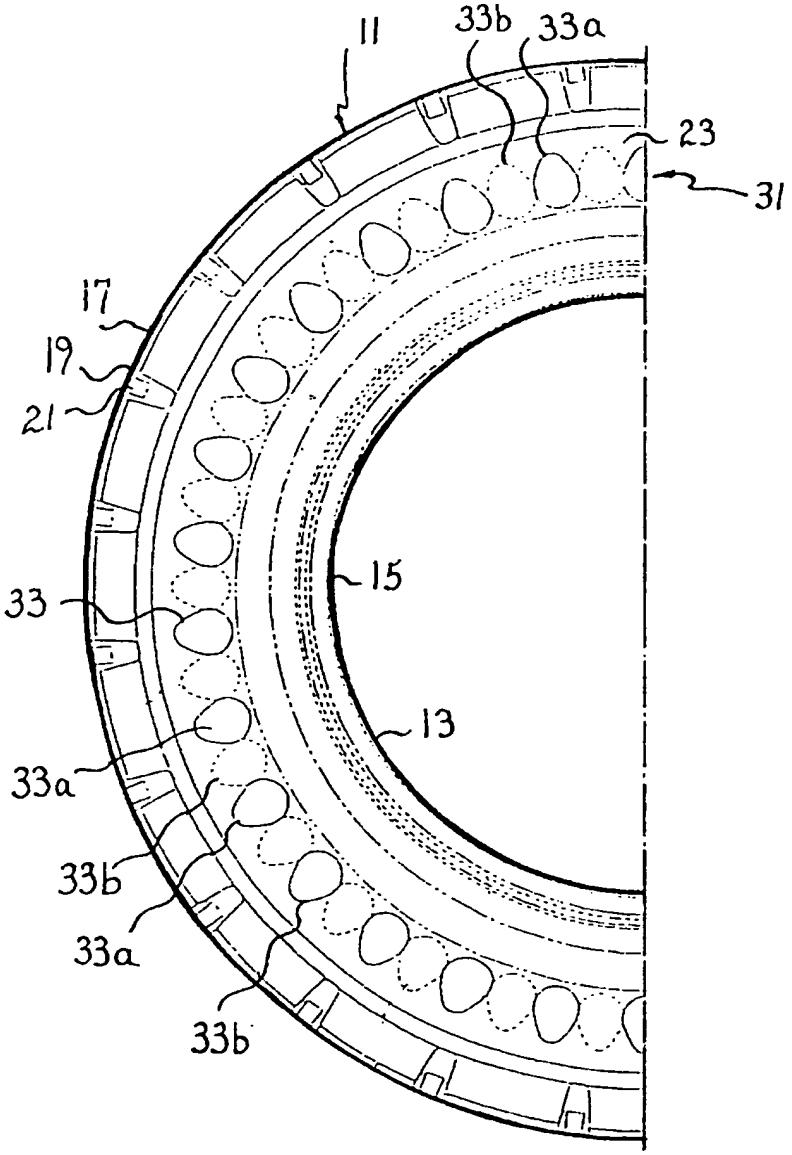

Fig. 12

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 96/00740

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: B60C 7/10, 7/08, B62D 55/26, 55/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC : B60C 7/10, 7/08, B62D 55/26, 55/24.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU : IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Derwent and Japio with keywords: TYRE or TIRE or TRACK; CAVITY or HOLE or RECESS; OFFSET or OFF(W)SET or STAGGER.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 502353 A1 (THE GOODYEAR TIRE & RUBBER COMPANY) 9 September 1992 See figures.	1 to 22
X	US 4945962 A (PATJAS) 7 August 1990 See figures	1 to 22
X	WO 89/05736 A1 (ALTRACK LTD) 29 June 1989 See figures	1 to 22

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 February 1997	27 FEB 1997
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (06) 285 3929	Authorized officer PETER T. WEST Telephone No.: (06) 283 2108

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 96/00740

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, X	WO 96/5917 A1 (AIRBOSS TYRES PTY LTD) 29 February 1996. See figures	1 to 22
A	WO 95/05947 A1 (AIRBOSS LIMITED) 2 March 1995 Whole document	
A	WO 95/03183 A1 (AIRBOSS LIMITED) 2 February 1995 Whole document	
A	AU 64950/90 (649630) B (ALTRACK LIMITED) Whole document	
P, A	GB 2297298 A (AIRBOSS TYRES PTY LTD) 31 July 1996 Whole document	
A	US 1365539 A (PEPPLE) 11 January 1921 Whole document	
A	Patent Abstracts of Japan, JP 7-205608 A (SUMITOMO RUBBER IND LTD) 8 August 1995 Whole document	

INTERNATIONAL SEARCH REPORT

Information on patent family members

Internauonal Application No.
PCT/AU 96/00740

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
EP	502353	CA	2043082	EP	502353	JP	5077605
		US	5343916				
US	4945962	BR	9002719	CA	2016660	EP	401564
		JP	3025004	US	4945962		
WO	8905736	AU	28241/89	BR	8807850	CA	1331731
		EP	391946	GR	88100836	IN	172237
		PL	276497	PT	89215	SU	1807951
		US	5139066	WO	8905736	ZA	8809146
WO	9605917	AU	32469/95	WO	9605917	ZA	9506903

END OF ANNEX